

## CLAIMS

1. An electrode for discharge surface treatment that is used for discharge surface treatment for causing, with a green compact obtained by compression-molding powder  
5 containing metal or a metallic compound as an electrode, electric discharge between the electrode and a work piece in a machining fluid or in an air and forming, using discharge energy of the electric discharge, a film  
10 consisting of an electrode material or a substance generated by reaction of the electrode material due to the discharge energy on a surface of the work piece, wherein  
the powder has an average value of particle diameters not more than 3 micrometers.
- 15 2. An electrode for discharge surface treatment that is used for discharge surface treatment for causing, with a green compact obtained by compression-molding powder containing metal or a metallic compound as an electrode, electric discharge between the electrode and a work piece  
20 in a machining fluid or in an air and forming, using discharge energy of the electric discharge, a film consisting of an electrode material or a substance generated by reaction of the electrode material due to the discharge energy on a surface of the work piece, wherein  
25 powder having a particle diameter not more than 3 micrometers is mixed in the powder.
3. The electrode for discharge surface treatment according to claim 2, wherein the powder has a particle  
30 diameter varied in powder of an identical component.
4. The electrode for discharge surface treatment according to any one of claims 1 to 3, wherein the powder

contains any one of stellite, Ti-coated CBN, Ti+Ti,  $\text{Cr}_2\text{C}_3+\text{Cr}$ ,  $\text{Cr}_2\text{C}_3+\text{stellite}$ ,  $\text{Al}_2\text{O}_3+\text{Ni}$ ,  $\text{ZrO}_2+\text{Ni}$ , and stellite+Co.

5. An electrode for discharge surface treatment that is  
5 used for discharge surface treatment for causing, with a  
green compact obtained by compression-molding powder of  
metal, a metallic compound, or ceramics as an electrode,  
electric discharge between the electrode and a work piece  
in a machining fluid or in an air and forming, using  
10 discharge energy of the electric discharge, a film  
consisting of an electrode material or a substance  
generated by reaction of the electrode material due to the  
discharge energy on a surface of the work piece, wherein  
the powder has an aspherical shape.

15 6. The electrode for discharge surface treatment  
according to claim 5, wherein a shape of the powder is a  
scaly shape or a polyhedron shape.

20 7. The electrode for discharge surface treatment  
according to claim 6, wherein an average particle diameter  
of the powder is not more than 3 micrometers.

8. An electrode for discharge surface treatment that is  
25 used for discharge surface treatment for causing, with a  
green compact obtained by compression-molding powder of  
metal or a metallic compound as an electrode, electric  
discharge between the electrode and a work piece in a  
machining fluid or in an air and forming, using discharge  
30 energy of the electric discharge, a film consisting of an  
electrode material or a substance generated by reaction of  
the electrode material due to the discharge energy on a  
surface of the work piece, wherein

the powder is obtained by mixing a small-diameter powder having a distribution of small particle diameters and a large-diameter powder having an average particle diameter twice or more as large as the small-diameter powder.

9. An electrode for discharge surface treatment that is used for discharge surface treatment for causing, with a green compact obtained by compression-molding powder of metal or a metallic compound as an electrode, electric discharge between the electrode and a work piece in a machining fluid or in an air and forming, using discharge energy of the electric discharge, a film consisting of an electrode material or a substance generated by reaction of the electrode material due to the discharge energy on a surface of the work piece, wherein

the powder is obtained by mixing a small-diameter powder having a distribution of small particle diameters not more than 3 micrometers and a large-diameter powder having an average particle diameter not less than 5 micrometers.

10. The electrode for discharge surface treatment according to claim 8 or 9, wherein the small-diameter powder is metal powder refined by grinding.

11. The electrode for discharge surface treatment according to any one of claims 8 to 10, wherein the large-diameter powder has a substantially spherical shape.

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12. The electrode for discharge surface treatment according to any one of claims 8 to 11, wherein the powders to be mixed have an identical component.

13. The electrode for discharge surface treatment according to any one of claims 8 to 12, wherein the powder is any one of Co alloy, Ni alloy, and Fe alloy.

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14. The electrode for discharge surface treatment according to any one of claims 8 to 13, wherein the large-diameter powder is in 5 to 60 volume percent.

10 15. The electrode for discharge surface treatment according to any one of claims 8 to 13, wherein the large-diameter powder is in 5 to 20 volume percent.

16. An electrode for discharge surface treatment that is  
15 used for discharge surface treatment for causing, with a green compact obtained by compression-molding powder of metal, a metallic compound, or ceramics as an electrode, electric discharge between the electrode and a work piece in a machining fluid or in an air and forming, using  
20 discharge energy of the electric discharge, a film consisting of an electrode material or a substance generated by reaction of the electrode material due to the discharge energy on a surface of the work piece, wherein  
the powder has an average value of particle diameters  
25 not more than 1 micrometer.

17. An electrode for discharge surface treatment that is used for discharge surface treatment for causing, with a green compact obtained by compression-molding powder of  
30 metal, a metallic compound, or ceramics as an electrode, electric discharge between the electrode and a work piece in a machining fluid or in an air and forming, using discharge energy of the electric discharge, a film

consisting of an electrode material or a substance generated by reaction of the electrode material due to the discharge energy on a surface of the work piece, wherein

the powder contains a predetermined quantity or more  
5 of powder with an average value of particle diameters not more than 1 micrometer as the electrode material.

18. The electrode for discharge surface treatment according to claim 16 or 17, wherein the powder contains  
10 any one of Co powder, Co alloy powder, Mo powder, Cr powder, W powder, Zr powder, Ta powder, Ti powder, V powder, and Nb powder.

19. A manufacturing method for an electrode for discharge  
15 surface treatment, comprising:

a first step of grinding powder of metal, a metallic compound, or ceramics into aspheric powder having a predetermined particle diameter with a grinder; and

a second step of compress-molding the powder ground  
20 into a predetermined shape to have predetermined hardness.

20. The manufacturing method for an electrode for discharge surface treatment according to claim 19, wherein the grinder is a mill apparatus.

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21. The manufacturing method for an electrode for discharge surface treatment according to claim 20, wherein the mill apparatus is any one of a ball mill apparatus, a bead mill apparatus, a vibrating mill apparatus, and a jet  
30 mill apparatus.

22. The manufacturing method for an electrode for discharge surface treatment according to claim 20 or 21,

wherein the mill apparatus includes a container and balls made of a same material as material of the powder to be ground.

5 23. The manufacturing method for an electrode for discharge surface treatment according to claim 20 or 21, wherein the mill apparatus includes a container and balls with surfaces thereof subjected to build up welding, plating, or thermal spraying using a same material as a  
10 material of the powder to be ground.

24. The manufacturing method for an electrode for discharge surface treatment according to claim 20, wherein a material of the mill apparatus is  $ZrO_2$ .

15 25. The manufacturing method for an electrode for discharge surface treatment according to any one of claims 19 to 24, wherein, in the first step, the predetermined particle diameter is not more than 3 micrometers.

20 26. A discharge surface treatment method of causing, with a green compact obtained by compression-molding powder containing metal or a metallic compound as an electrode, electric discharge between the electrode and a work piece  
25 in a machining fluid or in an air and forming, using discharge energy of the electric discharge, a film consisting of an electrode material or a substance generated by reaction of the electrode material due to the discharge energy on a surface of the work piece, wherein  
30 the film is formed using an electrode obtained by compression-molding powder with an average value of particle diameters not more than 3 micrometers.

27. A discharge surface treatment method of causing, with a green compact obtained by compression-molding powder containing metal or a metallic compound as an electrode, electric discharge between the electrode and a work piece  
5 in a machining fluid or in an air and forming, using discharge energy of the electric discharge, a film consisting of an electrode material or a substance generated by reaction of the electrode material due to the discharge energy on a surface of the work piece, wherein  
10 the film is formed using an electrode obtained by compression-molding powder mixed with powder having a particle diameter not more than 3 micrometers.

28. A discharge surface treatment method of causing, with  
15 a green compact obtained by compression-molding powder of metal or a metallic compound as an electrode, electric discharge between the electrode and a work piece and forming, using discharge energy of the electric discharge, a film consisting of an electrode material or a substance  
20 generated by reaction of the electrode material due to the discharge energy on a surface of the work piece, wherein the film is formed using an electrode obtained by mixing a small-diameter powder having a distribution of small particle diameters and a large-diameter powder having  
25 an average particle diameter twice or more as large as the small-diameter powder and compression-molding the powders.

29. A discharge surface treatment method of causing, with a green compact obtained by compression-molding powder of  
30 metal or a metallic compound as an electrode, electric discharge between the electrode and a work piece and forming, using discharge energy of the electric discharge, a film consisting of an electrode material or a substance

generated by reaction of the electrode material due to the discharge energy on a surface of the work piece, wherein

the film is formed using an electrode obtained by mixing a small-diameter powder having a distribution of  
5 small particle diameters not more than 3 micrometers and a large-diameter powder having an average particle diameter not less than 5 micrometers and compression-molding the powders.

10 30. The discharge surface treatment method according to claims 28 or 29, wherein the small-diameter powder is powder refined by grinding.

31. The discharge surface treatment method according to  
15 any one of claims 28 to 30, wherein the large-diameter powder has a substantially spherical shape.

32. The discharge surface treatment method according to any one of claims 28 to 31, wherein the small-diameter  
20 particle and the large-diameter particle have an identical component.

33. The discharge surface treatment method according to any one of claims 28 to 32, wherein the powder is any one  
25 of Co alloy, Ni alloy, and Fe alloy.

34. The discharge surface treatment method according to any one of claims 28 to 33, wherein the large-diameter powder is in 5 to 60 volume percent.

30 35. The discharge surface treatment method according to any one of claims 28 to 33, wherein the large-diameter powder is in 5 to 20 volume percent.



36. The discharge surface treatment method according to any one of claims 28 to 35, wherein

the electrode and the work piece are arranged in a machining fluid or a predetermined gas atmosphere, and electric discharge is performed in the machining fluid or the predetermined gas atmosphere.

37. The discharge surface treatment method according to any one of claims 28 to 36, wherein a pulse current with a discharge pulse width not more than 70 microseconds and a peak current value not more than 30 amperes is supplied between the electrode and the work piece.

38. A discharge surface treatment method of causing electric discharge between an electrode consisting of a green compact obtained by compression-molding powder with an average value of particle diameters not more than 1 micrometer and a work piece and forming, using discharge energy of the electric discharge, a film consisting of an electrode material or a substance generated by reaction of the electrode material due to the discharge energy on a surface of the work piece.

39. The discharge surface treatment method of causing electric discharge between an electrode consisting of a green compact obtained by compression-molding powder including a predetermined quantity or more of powder with an average value of particle diameters not more than 1 micrometer and a work piece and forming, using discharge energy of the electric discharge, a film consisting of an electrode material or a substance generated by reaction of the electrode material due to the discharge energy on a

surface of the work piece.

40. The discharge surface treatment method according to any one of claims 38 to 39, wherein

5       the electrode and the work piece are arranged in a machining fluid or a predetermined gas atmosphere, and  
      electric discharge is performed in the machining fluid or the predetermined gas atmosphere.

10 41. The discharge surface treatment method according to any one of claims 38 to 39, wherein a pulse current with a discharge pulse width not more than 70 microseconds and a peak current value not more than 30 amperes is supplied between the electrode and the work piece.

15 42. The discharge surface treatment method according to any one of claims 38 to 41, wherein the powder is powder of metal, a metal compound, or ceramics.

20 43. A discharge surface treatment apparatus that has an electrode consisting of a green compact obtained by compression-molding powder containing metal or a metallic compound and a work piece on which a film is formed, the electrode and the work piece being arranged in a machining  
25 fluid or in an air, generates a pulse-like electric discharge between the electrode and the work piece using a power supply apparatus electrically connected to the electrode and the work piece, and forms, using discharge energy of the electric discharge, a film consisting of an  
30 electrode material or a substance generated by reaction of the electrode material due to the discharge energy on a surface of the work piece, wherein

      the electrode is manufactured by compression-molding

powder having an average value of particle diameters not more than 3 micrometers.

44. A discharge surface treatment apparatus that has an  
5 electrode consisting of a green compact obtained by  
compression-molding powder containing metal or a metallic  
compound and a work piece on which a film is formed, the  
electrode and the work piece being arranged in a machining  
fluid or in an air, generates a pulse-like electric  
10 discharge between the electrode and the work piece using a  
power supply apparatus electrically connected to the  
electrode and the work piece, and forms, using discharge  
energy of the electric discharge, a film consisting of an  
electrode material or a substance generated by reaction of  
15 the electrode material due to the discharge energy on a  
surface of the work piece, wherein

the electrode is manufactured by compression-molding  
powder mixed with powder having a particle diameter not  
more than 3 micrometers.

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45. A discharge surface treatment apparatus comprising:  
an electrode consisting of a green compact obtained by  
compression-molding powder of metal or a metal compound;  
a work piece on which a film is formed; and  
25 a power supply apparatus electrically connected to the  
electrode and the work piece,

the discharge surface treatment apparatus generating  
pulse-like electric discharge between the electrode and the  
work piece with the power supply apparatus and forming,  
30 using discharge energy of the discharge, a film consisting  
of an electrode material or a substance generated by  
reaction of the electrode material due to the discharge  
energy on a surface of the work piece, wherein

the electrode is manufactured by compression-molding powder obtained by mixing a small-diameter powder having a distribution of small particles and a large-diameter powder having an average particle diameter twice or more as large  
5 as the small-diameter powder.

46. A discharge surface treatment apparatus comprising:  
an electrode consisting of a green compact obtained by compression-molding powder of metal or a metal compound;  
10 a work piece on which a film is formed; and  
a power supply apparatus electrically connected to the electrode and the work piece,  
the discharge surface treatment apparatus generating pulse-like electric discharge between the electrode and the  
15 work piece with the power supply apparatus and forming, using discharge energy of the discharge, a film consisting of an electrode material or a substance generated by reaction of the electrode material due to the discharge energy on a surface of the work piece, wherein  
20 the electrode is manufactured by compression-molding powder obtained by mixing a small-diameter powder having a distribution of small particles not more than 3 micrometers and a large-diameter powder having an average particle diameter not less than 5 micrometers.

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47. The discharge surface treatment apparatus according to claims 45 or 46, wherein the small-diameter powder is powder refined by grinding.

30 48. The discharge surface treatment apparatus according to any one of claims 45 to 47, wherein the large-diameter powder has a substantially spherical shape.

49. The discharge surface treatment apparatus according to any one of claims 45 to 48, wherein the small-diameter particle and the large-diameter particle have an identical component.

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50. The discharge surface treatment apparatus according to any one of claims 45 to 49, wherein the powder is any one of Co alloy, Ni alloy, and Fe alloy.

10 51. The discharge surface treatment apparatus according to any one of claims 45 to 40, wherein the large-diameter powder is in 5 to 60 volume percent.

15 52. The discharge surface treatment apparatus according to any one of claims 45 to 50, wherein the large-diameter powder is in 5 to 20 volume percent.

53. The discharge surface treatment apparatus according to any one of claims 45 to 52, wherein  
20 the electrode and the work piece are arranged in a machining fluid or a predetermined gas atmosphere, and electric discharge is performed in the machining fluid or the predetermined gas atmosphere.

25 54. The discharge surface treatment apparatus according to any one of claims 45 to 53, wherein a pulse current with a discharge pulse width not more than 70 microseconds and a peak current value not more than 30 amperes is supplied between the electrode and the work piece.

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55. A discharge surface treatment apparatus comprising:  
an electrode consisting of a green compact obtained by compression-molding powder with an average value of

particle diameters not more than 1 micrometer;

a work piece on which a film is formed; and

a power supply apparatus electrically connected to the electrode and the work piece,

5        the discharge surface treatment apparatus generating pulse-like electric discharge between the electrode and the work piece with the power supply apparatus and forming, using discharge energy of the discharge, a film consisting of an electrode material or a substance generated by  
10       reaction of the electrode material due to the discharge energy on a surface of the work piece.

56. A discharge surface treatment apparatus comprising:

an electrode consisting of a green compact obtained by  
15       compression-molding powder containing a predetermined quality or more of powder with an average value of particle diameters not more than 1 micrometer;

a work piece on which a film is formed; and

a power supply apparatus electrically connected to the  
20       electrode and the work piece,

the discharge surface treatment apparatus generating pulse-like electric discharge between the electrode and the work piece with the power supply apparatus and forming, using discharge energy of the discharge, a film consisting  
25       of an electrode material or a substance generated by reaction of the electrode material due to the discharge energy on a surface of the work piece.

57. The discharge surface treatment apparatus according to  
30       any one of claims 55 to 56, wherein

the electrode and the work piece are arranged in a machining fluid or a predetermined gas atmosphere, and

electric discharge is performed in the machining fluid

or the predetermined gas atmosphere.

58. The discharge surface treatment apparatus according to any one of claims 55 to 56, wherein a pulse current with a  
5 discharge pulse width not more than 70 microseconds and a peak current value not more than 30 amperes is supplied between the electrode and the work piece.

59. The discharge surface treatment method according to  
10 any one of claims 55 to 56, wherein the powder is powder of metal, a metal compound, or ceramics.